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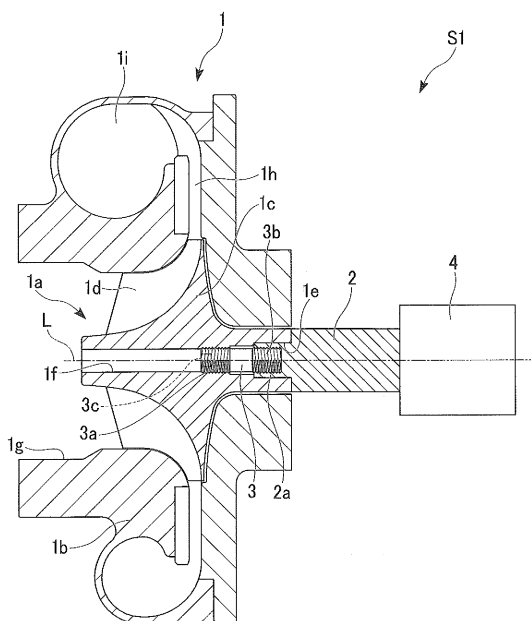
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(54) **TURBO DEVICE**

(57) In a turbomachinery (S1) that is provided with an impeller (1a) and a shaft (2) that are to be fastened, the impeller (1a) and the shaft (2) are fastened by a two-way screw (3) of which the turning direction of the screw thread that is formed on the impeller (1a) side and the

turning direction of the screw thread that is formed on the shaft (2) side are opposite directions. As a result, it is possible to fasten the impeller (1a) to the shaft (2) without the need for a complicated and large equipment, and the amount of work during fastening is reduced.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a turbomachinery.

Priority is claimed on Japanese Patent Application No. 2011-34519, filed February 21, 2011, the content of which is incorporated herein by reference.

BACKGROUND ART

[0002] A turbomachinery such as a turbocompressor or a supercharger is provided with an impeller that is rotatively driven by rotative power that is transmitted from a shaft.

In this kind of turbomachinery, for example, a male screw and a female screw are formed on an impeller and a shaft as shown in Patent Document 1 and Patent Document 2. The impeller and the shaft are then fastened by screwing together of the male screw and the female screw.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0003]

[Patent Document 1] Japanese Unexamined Utility Model Application, First Publication No. H05-52356

[Patent Document 2] Japanese Unexamined Utility Model Application, First Publication No. H05-57450

DISCLOSURE OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004] However, in a constitution in which a female screw and a male screw are formed on the impeller and the shaft as shown in Patent Document 1 and Patent Document 2, when fastening the impeller and the shaft, it is necessary to rotatively move the impeller with respect to the shaft.

That is to say, when attaching the impeller to the shaft, it is necessary, while rotatively moving the impeller, to gradually bring it close to the shaft.

For this reason, the movement amount of the impeller when attaching the impeller to the shaft is a great deal more than the case of attaching the impeller to the shaft without rotatively moving it. Accordingly, in the methods of Patent Document 1 and Patent Document 2, the amount of work required when fastening the impeller and the shaft ends up increasing.

[0005] Also, in order to prevent the impeller and the shaft from shifting in the rotation direction, it is preferable for sufficient frictional force to exist between the impeller and the shaft. For that reason, during attachment of the impeller to the shaft, after the impeller makes contact

with the seating surface of the shaft, it is preferable to push the impeller further to the shaft side, and cause the impeller to undergo elastic deformation.

However, after the impeller makes contact with the seating surface, the frictional resistance increases due to the frictional force that works between the impeller and the seating surface, and so the amount of work for pushing in the impeller to the shaft side increases.

[0006] On the other hand, firmly fastening the impeller and the shaft with hardly no rotational movement of the impeller with respect to the shaft is generally performed by using a tension bolt.

However, in the case of fastening the impeller and the shaft using a tension bolt, complex and large equipment such as a hydraulic tensioner is separately required.

[0007] The present invention was achieved in view of the above circumstances, and has as its object to, in a turbomachinery that is provided with an impeller and a shaft that are to be fastened, eliminating the need for complicated and large equipment and reducing the amount of work during fastening when fastening the impeller to the shaft.

MEANS FOR SOLVING THE PROBLEMS

[0008] In the present invention, the following means was adopted as a means for solving the above problems.

[0009] A turbomachinery according to a first aspect of the present invention is provided with an impeller that is rotatively driven and a shaft that transmits rotative force to the impeller, adopting a constitution having a two-way screw of which a first end side serves as an impeller screwing region that is screwed together with the impeller and a second end side serves as a shaft screwing region that is screwed together with the shaft, with the turning direction of the screw thread that is formed at the impeller screwing region and the turning direction of the screw thread that is formed at the shaft screwing region made to be opposite directions, and the impeller and the shaft being fastened by this two-way screw.

[0010] A turbomachinery according to a second aspect of the present invention adopts a constitution in which, in the aforementioned first aspect, the two-way screw is formed with a material having a higher thermal conductivity than the impeller.

[0011] A turbomachinery according to a third aspect of the present invention adopts a constitution in which, in the aforementioned second aspect, the two-way screw is formed with a steel material in the case of the impeller being formed with a titanium alloy.

[0012] A turbomachinery according to a fourth aspect of the present invention adopts a constitution providing a rotation inhibiting member that inhibits rotational movement of the impeller with respect to the shaft, in any of the first to third aspects.

[0013] A turbomachinery according to a fifth aspect of the present invention adopts a constitution in which, in the aforementioned fourth aspect, the rotation inhibiting

member, with the rotation axis direction of the impeller serving as the lengthwise direction, is a fitting hole that is provided at a position offset from the rotation axis of the impeller and a pin member that is fitted in a fitting hole that is provided at a position offset from the rotation axis of the shaft.

[0014] A turbomachinery according to a sixth aspect of the present invention adopts a constitution in which, in the aforementioned fifth aspect, the pin member is provided in a plurality at equally spaced intervals centered on the rotation axis of the impeller.

[0015] A turbomachinery according to a seventh aspect of the present invention adopts a constitution in which, in the aforementioned fourth aspect, the rotation inhibiting member is provided with a fitting projection whose outer shape seen from the rotation axis direction of the impeller deviates from the rotation body shape, and is provided projecting in the rotation axis direction with respect to the impeller or the shaft, and a fitting hole that is provided in the impeller or the shaft where the fitting projection is not provided, and in which the fitting projection is fitted.

[0016] A turbomachinery according to an eighth aspect of the present invention adopts a constitution in which, in the aforementioned seventh aspect, the fitting projection has a shape whose center of gravity is on the rotation axis.

[0017] A turbomachinery according to a ninth aspect of the present invention adopts a constitution in which any of the aforementioned first to eighth aspects is provided with a lock bolt that abuts the two-way screw from the rotation axis direction of the impeller.

[0018] A turbomachinery according to a tenth aspect of the present invention adopts a constitution in which, in any of the aforementioned first to ninth aspects, the turning direction of the screw thread that is formed on the impeller screwing region is set to a direction in which the fastening power between the two-way screw and the impeller increases due to a reactive force when the impeller is rotatively driven.

[0019] A turbomachinery according to an eleventh aspect of the present invention adopts a constitution in which, in any of the aforementioned first to tenth inventions, a fitting hole or a fitting projection that is capable of fitting a tool that rotates the two-way screw is provided on the impeller-side end face of the two-way screw, and an exposure hole that exposes the fitting hole or the fitting projection is provided in the impeller.

[0020] A turbomachinery according to a twelfth aspect of the present invention adopts a constitution in which, in the aforementioned eleventh aspect, the fitting hole or the fitting projection that is capable of fitting a tool that rotates the two-way screw has a shape whose center of gravity is centered on the rotation axis of the impeller.

EFFECTS OF THE INVENTION

[0021] In the present invention, the impeller and the

shaft are fastened by the two-way screw, in which the turning direction of the screw thread that is formed on the impeller side and the turning direction of the screw thread that is formed on the shaft side are opposite directions.

According to this kind of invention, by rotating the two-way screw, it is possible to cause the impeller and the shaft to move in a straight line along the rotation axis direction without the impeller undergoing rotative movement with respect to the shaft. That is to say, according to the present invention, compared to the case of fastening the impeller and the shaft while rotatively moving the impeller with respect to the shaft, it is possible to reduce the amount of movement of the impeller, and it is possible to cut down the amount of work during fastening.

Moreover, according to the present invention, when the impeller is pushed to the shaft side and made to undergo elastic deformation in order to ensure the frictional force with the shaft, it is possible to cause the impeller and the shaft to move in a straight line along the rotation axis direction without the impeller undergoing rotative movement with respect to the shaft. That is to say, according to the present invention, compared to the case of fastening the impeller and the shaft while rotatively moving the impeller with respect to the shaft, it is possible to reduce the friction resistance and possible to cut down the amount of work during fastening.

[0022] Also, in the present invention, since it is possible to fasten the impeller and the shaft without applying great tension to the two-way screw, there is no need for an additional complicated and large equipment such as a hydraulic tensioner.

[0023] Accordingly, according to the present invention, in a turbomachinery that is provided with an impeller and a shaft that are fastened, it is possible to cut down the work amount when fastening the impeller to the shaft without additionally requiring a complicated and large device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024]

FIG. 1 is a cross-sectional view that shows the outline constitution of the turbocompressor in the first embodiment of the present invention.

FIG. 2 is a schematic diagram for describing the work of fastening the compressor impeller and the shaft that the turbocompressor in the first embodiment of the present invention is provided with.

FIG. 3A is a cross-sectional view that shows the outline constitution of the turbocompressor in the second embodiment of the present invention.

FIG. 3B is a view on arrow seen from the rotation axis direction of the shaft of FIG. 3A.

FIG. 4A is a cross-sectional view that shows the outline constitution of the turbocompressor in the third embodiment of the present invention.

FIG. 4B is a view on arrow seen from the rotation axis direction of the shaft of FIG. 4A.

FIG. 5 is a cross-sectional view that shows the outline constitution of the turbocompressor in the fourth embodiment of the present invention.

FIG. 6 is a cross-sectional view that shows a modification of the turbocompressor in the first embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0025] Hereinbelow, referring to the drawings, one embodiment of the turbomachinery according to the present invention shall be described. Note that in the following drawings, the dimensional scale of the members is appropriately altered in order to make each member a size that is recognizable.

Also, in the following description, the description is made giving a turbocompressor as one example of the turbomachinery of the present invention, but the turbomachinery of the present invention is not limited to a turbocompressor, and it can also be applied to general turbomachineries provided with an impeller and a shaft such as a supercharger.

(First Embodiment)

[0026] FIG. 1 is a cross-sectional view that shows the outline constitution of a turbocompressor S1 of the present embodiment.

The turbocompressor S 1 is a machinery that compresses a gas such as air and emits it as compressed gas, and as shown in FIG. 1, is provided with a compressor 1, a shaft 2, a two-way screw 3, and a drive unit 4.

[0027] The compressor is a member for compressing gas by being driven, and is equipped with a compressor impeller 1a (equivalent to the impeller of the present invention), and the compressor housing 1b.

[0028] The compressor impeller 1a is a member for imparting kinetic energy to gas to accelerate it, and is a radial impeller that accelerates gas that is taken in from a rotation axis L direction, and discharges it in a radial direction.

As shown in FIG. 1, the compressor impeller 1a is provided with a base portion 1c that is fastened to the shaft 2, and a plurality of wings 1d that are arranged at equal intervals in the rotation direction on the surface of the base portion 1c.

[0029] Also, in the base portion 1c is provided a fitting hole 1e that is opened facing the drive unit 4 and in which a fitting projection 2a that the shaft 2 is provided with is fitted.

Also, in the interior of the base portion 1c, as shown in FIG. 1, a housing space of the two-way screw 3 is provided in communication with the fitting hole 1e. A screw thread is formed in the inner wall surface of this housing space and constituted so as to be a female thread that a first end side of the two-way screw 3 can be screwed

together with.

Moreover, in the base portion 1c, an exposure hole 1f that exposes a first end face of the two-way screw 3 is formed from a distal end of the compressor impeller 1a.

5 Note that the exposure hole 1f has a diameter that allows the passing through of a tool 10 that rotates the two-way screw 3 described later (refer to FIG. 2), and is provided along the rotation axis L of the compressor impeller 1a. Note, as shown in FIG. 1, the fitting hole 1e and the exposure hole 1f sandwich the housing space of the two-way screw 3, and are arranged so as to be concentric with the rotation axis L of the compressor impeller 1a.

[0030] The compressor impeller 1a is formed for example with a titanium alloy, an aluminum alloy, or stainless steel, depending on the gas to be compressed.

[0031] The compressor housing 1b forms the outer shape of the compressor 1, has a gas flow passage in the interior, and houses the compressor impeller 1a in the interior.

20 In this compressor housing 1b, as shown in FIG. 1, an intake opening 1g that intakes gas, a diffuser 1h that decelerates and compresses the gas that has been accelerated by the compressor impeller 1a, a scroll flow passage 1i that serves as the flow passage of the compressed gas, and a discharge opening that is not illustrated from which the compressed gas is discharged.

[0032] The shaft 2 is a member for transmitting power generated by the drive unit 4 as rotative power to the compressor impeller 1a, and is connected with the drive unit 4.

30 At a first end of the shaft 2, a fitting projection 2a is provided for fitting in the fitting hole 1e provided in the base portion 1c of the compressor impeller 1a, and by the fitting projection 2a being fitted in the fitting hole 1e, the compressor impeller 1a and the shaft 2 are positioned so as to be coaxial.

35 Also, as shown in FIG. 1, a female screw that a second end side of the two-way screw 3 is capable of screwing together with is provided in the fitting projection 2a.

40 The shaft 2 is formed for example with a steel material (for example, a steel material including chrome and molybdenum).

[0033] The two-way screw 3 is a member for fastening the compressor impeller 1a and the shaft 2. The first end side of this two-way screw 3 serves as an impeller screwing region 3a that is screwed together with the compressor impeller 1a, while the second end side serves as a shaft screwing region 3b that is screwed together with the shaft 2.

50 The turning direction of the screw thread that is formed on the impeller screwing region 3a and the turning direction of the screw thread that is formed on the impeller screwing region 3b are opposite directions.

55 For this reason, when the two-way screw 3 is turned in one direction, the compressor impeller 1a and the shaft 2 are draw close along the rotation axis L, and when the two-way screw 3 is reversed, the compressor impeller 1a and the shaft 2 separate along the rotation axis L.

Note that the turning direction of the screw thread that is formed on the impeller screwing region 3a is set to a direction in which the fastening power between the two-way screw 3 and the compressor impeller 1a increases due to a reactive force when the compressor impeller 1a is rotatively driven.

[0034] Also, in the first end face of the two-way screw 3 (a face on the compressor impeller 1a side), a fitting hole 3c for fitting a tool 10 for rotating the two-way screw 3 is provided. The shape of this fitting hole 3a is set to a shape, viewed from the rotation axis L direction, whose center of gravity is on the rotation axis L (for example, a hexagonal shape). In this way, by making the shape of the fitting hole 3c have a shape whose center of gravity is on the rotation axis L, when the compressor impeller 1a is rotated, it is possible to keep the weight distribution of the compressor impeller 1a that is centered on the rotation axis L uniform, and it is possible to rotate the compressor impeller 1a in a stable manner.

Note that the first end face of the two-way screw 3 is exposed by the exposure hole 1f that is provided in the base portion 1c of the compressor impeller 1a as described above. For this reason, the fitting hole 3c that is formed in the first end face of the two-way screw 3 is exposed from a first end of the compressor impeller 1a via the exposure hole 1f.

[0035] Note that as long as the rigidity required for fastening of the compressor impeller 1a and the shaft 2 is ensured, it is preferable for the two-way screw 3 to be formed with a material having a higher thermal conductivity than the compressor impeller 1a.

Specifically, in the case of for example the compressor impeller 1a being formed with a titanium alloy, it is conceivable for the two-way screw 3 to be formed with a steel material.

In this way, by forming the two-way screw 3 with a material having a higher thermal conductivity than the compressor impeller 1a, it is possible to promote heat transfer from the compressor impeller 1a, which has risen in temperature due to the compression of gas, to the shaft 2, and it is possible to promptly transfer the heat to lubricating oil that is to be cooled by a cooling mechanism not shown.

Also, in the case of the two-way screw 3 being formed with a steel material, and the compressor impeller 1a being formed with a titanium alloy, the thermal expansion of the two-way screw 3 becomes greater than the compressor impeller 1a. For that reason, while there is a possibility of the compressor impeller 1a and the shaft 2 separating when the fastening portion becomes a high temperature, when it is possible to reduce the temperature change of the fastening portion by cooling through heat transfer enhancement due to the two-way screw 3 as described above, it is possible to reduce the thermal expansion and so possible to prevent separation of the compressor impeller 1a and the shaft 2. For this reason, it is possible to inhibit loosening of the fastening power between for example the compressor impeller 1a and the

two-way screw 3.

Note that in the present embodiment, the two-way screw 3 and the compressor impeller 1a are screwed together, and the two-way screw 3 and the shaft 2 are screwed together. For this reason, the contact surface between the two-way screw 3 and the compressor impeller and the contact surface area between the two-way screw 3 and the shaft 2 broaden, the heat transmission area increases, and it is possible to further promote the aforementioned heat transfer.

[0036] The drive unit 4 is a member for generating power for rotatively driving the compressor impeller 1a and transmitting it to the shaft 2, and for example, is constituted to include a motor and gears and the like.

[0037] During assembly of the turbocompressor S1 of the present embodiment having this kind of constitution, when fastening the compressor impeller 1a and the shaft, first the impeller screwing region 3a of the two-way screw 3 is slightly screwed together with the female screw that is provided in the compressor impeller 1a, and the shaft screwing region 3b is slightly screwed together with the female screw that is provided in the shaft 2. Alternatively, the shaft screwing region 3b is slightly screwed together with the female screw that is provided in the shaft 2, and the impeller screwing region 3a is slightly screwed together with the female screw that is provided in the compressor impeller 1a.

[0038] Next, as shown in FIG. 2, the tool 10 (hex wrench) is inserted in the exposure hole 1f that is provided in the base portion 1c of the compressor impeller 1a, and a distal end of the tool 10 is fitted in the fitting hole 3c that is exposed from the first end of the compressor impeller 1a via the exposure hole 1f. Then, by rotating the tool 10, the two-way screw 3 is rotated.

As a result, the compressor impeller 1a moves in a straight line along the rotation axis L without undergoing rotative movement with respect to the shaft 2. By rotating the two-way screw 3 until the fitting projection 2a is fitted in the fitting hole 1e and the compressor impeller 1a and the shaft 2 are in close contact, the compressor impeller 1a and the shaft 2 are fastened.

[0039] In the turbocompressor S1 of the present embodiment, the compressor impeller 1a and the shaft 2 are fastened by the two-way screw 3, in which the turning direction of the screw thread that is formed on the compressor impeller 1a side and the turning direction of the screw thread that is formed on the shaft 2 side are opposite directions.

For this reason, by rotating the two-way screw 3, it is possible to cause the compressor impeller 1a and the shaft 2 to move in a straight line along the rotation axis L direction without the compressor impeller 1a undergoing rotative movement with respect to the shaft 2. That is to say, according to the turbocompressor S1 of the present embodiment, compared to the case of fastening the compressor impeller 1a and the shaft 2 while rotatively moving the compressor impeller 1a with respect to the shaft 2, it is possible to reduce the amount of move-

ment of the compressor impeller 1a, and it is possible to cut down the amount of work during fastening.

Also, in the turbocompressor S1 of the present embodiment, since it is possible to fasten the compressor impeller 1a and the shaft 2 without applying great tension to the two-way screw 3, there is no need for an additional complicated and large equipment such as a hydraulic tensioner.

Accordingly, with the turbocompressor S1 of the present embodiment, it is possible to cut down the work amount when fastening the compressor impeller 1a to the shaft 2 without additionally requiring a complicated and large device.

[0040] Also, in the turbocompressor S1 of the present embodiment, the turning direction of the screw thread that is formed on the impeller screwing region 3a is set to a direction in which the fastening power between the two-way screw 3 and the compressor impeller 1a increases due to a reactive force when the compressor impeller 1a is rotatively driven.

For this reason, with the turbocompressor S1 of the present embodiment, it is possible to inhibit loosening of the fastening power between the compressor impeller 1a and the two-way screw 3 during operation.

[0041] Also, in the turbocompressor S1 of the present embodiment, the fitting hole 3c that is capable of fitting the tool 10 that rotates the two-way screw 3 is provided in the end face of the two-way screw 3 on the compressor impeller 1a side, and the exposure hole 1f that exposes the fitting hole 3c is provided in the compressor impeller 1a.

For this reason, by inserting the tool 10 through the exposure hole 1f, it is possible to easily turn the two-way screw 3.

[0042] Also, in the turbocompressor S1 of the present embodiment, in order to fasten the compressor impeller 1a and the shaft 2 by the two-way screw 3, there is no need to extend the shaft 2 until the distal end of the compressor impeller 1a in the manner of a conventional turbocompressor in order to fix the compressor impeller 1a. As a result, the shaft 2 becomes short, and so it is possible to improve the rigidity of the shaft 2.

(Second Embodiment)

[0043] Next, a second embodiment of the present invention shall be described. Note that in the description of the second embodiment, for those portions that are the same as in the aforementioned first embodiment, descriptions thereof shall be omitted or simplified.

[0044] FIG. 3A and FIG. 3B are drawings that show the outline constitution of the turbocompressor S2 of the present embodiment. FIG. 3A is a cross-sectional view, while FIG. 3B is a view on arrow of the shaft 2 seen from the rotation axis L direction.

As shown in these drawings, the turbocompressor S2 of the present embodiment is, with the rotation axis L direction serving as the lengthwise direction, equipped with a

fitting hole that is provided at a position offset from the rotation axis L of the compressor impeller 1a, and a pin member 5 to be fitted in the fitting hole that is provided at a position offset from the rotation axis L of the shaft 2.

[0045] The pin member 5 is a member for inhibiting rotational movement of the compressor impeller 1a with respect to the shaft 2, and functions as a rotation inhibiting member of the present invention.

In the turbocompressor S2 of the present embodiment, as shown in FIG. 3B, a plurality of the pin members 5 are arranged at equally spaced intervals centered on the rotation axis L of the compressor impeller 1a.

[0046] According to the turbocompressor S2 of the present embodiment having this kind of constitution, when attaching the compressor impeller 1a to the shaft 2 by the pin members 5, it is possible to inhibit rotational movement of the compressor impeller 1a, and it is possible to fasten the compressor impeller 1a and the shaft 2 in a stable manner.

Also, according to the turbocompressor S2 of the present embodiment that has this kind of constitution, the pin members 5 function as reinforcing members at the joining location of the compressor impeller 1a and the shaft 2. For this reason, it is possible to increase the strength of the joining location of the compressor impeller 1a and the shaft 2.

[0047] Note that when fastening the compressor impeller 1a and the shaft 2, the pin members 5 are fitted in either one of the compressor impeller 1a and the shaft 2, and then fitted in the other by bringing the compressor impeller 1a and the shaft 2 together by rotation of the two-way screw 3.

For this reason, it is not possible to arrange the pin members 5 in a conventional fastening method that rotationally moves the compressor impeller 1a with respect to the shaft 2 when fastening the compressor impeller 1a and the shaft 2.

That is to say, the turbocompressor S2 of the present embodiment realizes an improvement in strength at the joining location of the compressor impeller 1a and the shaft 2 that cannot be realized in a turbocompressor that uses the conventional fastening method of rotatively moving the compressor impeller 1a with respect to the shaft 2.

[0048] Also, in the turbocompressor S2 of the present embodiment, a plurality of the pin members 5 are provided at equally spaced intervals centered on the rotation axis L of the compressor impeller 1a.

For that reason, when rotatively driving the compressor impeller 1a, it is possible to uniformly maintain the weight distribution centered on the rotation axis L, and so it is possible to rotate the compressor impeller 1a in a stable manner.

(Third Embodiment)

[0049] Next, a third embodiment of the present invention shall be described. Note that in the description of the

third embodiment, for those portions that are the same as in the aforementioned first embodiment, descriptions thereof shall be omitted or simplified.

[0050] FIG. 4A and FIG. 4B are drawings that show the outline constitution of the turbocompressor S3 of the present embodiment. FIG. 4A is a cross-sectional view, while FIG. 4B is a view on arrow of the shaft 2 seen from the direction of the rotation axis L.

As shown in these drawings, the turbocompressor S3 of the present embodiment is equipped with a fitting projection 7 of which the shape seen from the rotation axis L direction of the compressor impeller 1a is an approximately triangular shape having rounded apices (a shape deviating from the rotation body shape) whose center of gravity is on the rotation axis L, and a fitting hole 6 that the fitting projection 7 is fitted into.

[0051] By fitting together, this kind of fitting projection 7 and fitting hole 6 function as a rotation inhibiting member of the present invention, by inhibiting rotational movement of the compressor impeller 1a with respect to the shaft 2.

[0052] Note that in the turbocompressor S3 of the present embodiment, the fitting projection 7 is provided at the shaft 2, while the fitting hole 6 is provided in the compressor impeller 1a.

Note that it is also possible to adopt a constitution that conversely provides the fitting projection 7 in the compressor impeller 1a, and provides the fitting hole 6 in the shaft 2.

[0053] According to the turbocompressor S3 of the present embodiment having this kind of constitution, when attaching the compressor impeller 1a to the shaft 2 by the fitting projection 7 and the fitting hole 6, it is possible to inhibit rotational movement of the compressor impeller 1a, and so it is possible to fasten the compressor impeller 1a and the shaft 2 in a stable manner.

[0054] Also, in the turbocompressor S3 of the present embodiment, the fitting projection 7 has a shape whose center of gravity is on the rotation axis L.

For this reason, when rotationally driving the compressor impeller 1a, it is possible to uniformly maintain the weight distribution centered on the rotation axis L, and so it is possible to rotate the compressor impeller 1a in a stable manner.

(Fourth Embodiment)

[0055] Next, a fourth embodiment of the present invention shall be described. Note that in the description of the fourth embodiment, for those portions that are the same as in the aforementioned first embodiment, descriptions thereof shall be omitted or simplified.

[0056] FIG. 5 is a cross-sectional view that shows the outline constitution of the turbocompressor S4 of the present embodiment.

As shown in this drawing, the turbocompressor S4 of the present embodiment is provided with a lock bolt 8 that abuts the two-way screw 3 from the rotation axis L direc-

tion of the compressor impeller 1a (left side of the page). Note that the turning direction of the screw thread that is formed on the impeller screwing region 3a of the two-way screw 3 and the turning direction of the screw thread that the lock bolt 8 is provided with are the same directions.

[0057] Note that in the lock bolt 8 there is provided a tool hole (for example with a hexagonal shape) that penetrates in the rotation axis L direction and that is used when fastening or loosening the lock bolt 8. The inscribed circle of this tool hole is set to be larger than the circumscribed circle of the tool 10 that fits in the fitting hole 3c of the two-way screw 3. For this reason, the tool 10 can fit in the two-way screw 3 by passing through the lock bolt 8.

[0058] According to the turbocompressor S4 of the present embodiment having this constitution, even in the case of the compressor impeller 1a attempting to undergo rotational movement in the direction of loosening of the fastening power, it is possible to inhibit displacement of the two-way screw 3 in the rotation axis L direction by the lock bolt 8. As a result, it is possible to prevent rotational movement of the compressor impeller 1a in the direction of loosening of the fastening power.

[0059] Hereinabove, the preferred embodiments of the present invention were described while referring to the appended drawings, but it goes without saying that the present invention is not to be limited to the aforementioned embodiments. The various shapes and combinations of the respective component members shown in the above embodiments are examples only, and various changes are possible based on design requirements within a scope of the present invention.

[0060] For example, in the aforementioned embodiments, it is also possible to make the pitch of the screw thread that is formed at the impeller screwing region 3a and the pitch of the screw thread that is formed at the shaft screwing region 3b differ.

By adopting this kind of constitution, the amount of movement of the compressor impeller 1a and the amount of movement of the shaft 2 per unit rotation of the two-way screw 3 change. In other words, the rotation amount of the two-way screw 3 with respect to the unit movement amount of the compressor impeller 1a and the shaft 2 differs.

As a result, when the turbocompressor is running, it is possible to inhibit rotation of the two-way screw 3 when the compressor impeller 1a and the shaft 2 attempt to move in the rotation axis L direction. Thereby, it is possible to inhibit loosening of the fastening power between the compressor impeller 1a and the two-way screw 3.

[0061] Also, for example, in the aforementioned embodiments, the fitting projection 2a is provided at the shaft 2, and the fitting hole 1e is provided in the compressor impeller 1a.

However, as shown in FIG. 6, it is also possible to adopt a constitution that conversely provides a fitting projection in the compressor impeller 1a and provides a fitting hole

in the shaft 2.

By adopting this kind of constitution, as shown in FIG. 6, the two-way screw 3 is arranged greatly recessed in the interior of the shaft 2. For that reason, it is possible to allow the two-way screw 3 to escape from the root region of the maximum diameter portion in the compressor impeller 1a where the load becomes great due to the highest stress acting, and so it is possible to reduce the load that acts on the two-way screw 3.

Also, due to the two-way screw 3 leaving the maximum stress portion of the compressor impeller 1a, it is possible to apply a higher axial force to the compressor impeller 1a, and it is possible to increase the fastening power of the compressor impeller 1a and the shaft 2.

[0062] Also, in the aforementioned embodiments, in order to inhibit loosening of the fastening power due to thermal expansion during operation, an axial force that can mitigate loosening of the axial force due to thermal expansion may be applied to the two-way screw 3.

[0063] Also, in the aforementioned embodiments, as shown in FIG. 2, a constitution was adopted in which the two-way screw 3 is provided with a fitting hole 3a in which the tool 10 is fitted.

However, the present invention is not limited thereto, and it is also possible to adopt a constitution in which the two-way screw 3, instead of the fitting hole 3a, is equipped with a fitting projection that a tool is capable of fitting.

[0064] Also, in the aforementioned embodiments, a turbocompressor was described in which one shaft and one compressor impeller 1a at one end of the shaft are fastened.

However, the present invention is not limited thereto, and it can also be applied to a turbocompressor in which a compressor impeller 1a is fastened to both ends of one shaft, a turbocompressor that is provided with a plurality of shafts and in which a compressor impeller is provided at each shaft, and a turbocompressor that is provided with other equipment such as a cooler or the like that cools the compressed gas.

INDUSTRIAL APPLICABILITY

[0065] According to the present invention, in a turbomachinery that is provided with an impeller and a shaft that are to be fastened, when fastening the impeller to the shaft, there is no need for a complicated and large device, and it is possible to cut down on the amount of work during fastening.

DESCRIPTION OF REFERENCE SYMBOLS

[0066] S1~S4 turbocompressor (turbomachinery), 1 Compressor, 1a compressor impeller (impeller), 1b compressor housing, 1c base portion, 1d wing, 1e fitting hole, 1f exposure hole, 1g intake opening, 1h diffuser, 1i scroll flow passage, 2 shaft, 2a fitting projection, 3 two-way screw, 3a impeller screwing region, 3b shaft screwing region, 3c fitting hole, 4 drive unit, 5 pin member (rotation

inhibiting member), 6 fitting projection (rotation inhibiting member), 7 fitting hole (rotation inhibiting means), 8 lock bolt

Claims

1. A turbomachinery comprising an impeller that is rotatively driven and a shaft that transmits rotational power to the impeller, wherein the turbomachinery comprises a two-way screw of which a first end side serves as an impeller screwing region that is screwed together with the impeller and a second end side serves as a shaft screwing region that is screwed together with the shaft, with the turning direction of the screw thread that is formed at the impeller screwing region and the turning direction of the screw thread that is formed at the shaft screwing region made to be opposite directions, and the impeller and the shaft are fastened by the two-way screw.
2. The turbomachinery according to claim 1, wherein the two-way screw is formed with a material having a higher thermal conductivity than the impeller.
3. The turbomachinery according to claim 2, wherein the two-way screw is formed with a steel material in the case of the impeller being formed with a titanium alloy.
4. The turbomachinery according to claim 1, comprising a rotation inhibiting member that inhibits rotational movement of the impeller with respect to the shaft.
5. The turbomachinery according to claim 4, wherein the rotation inhibiting member, with the rotation axis direction of the impeller serving as the lengthwise direction, is a fitting hole that is provided at a position offset from the rotation axis of the impeller and a pin member that is fitted in a fitting hole that is provided at a position offset from the rotation axis of the shaft.
6. The turbomachinery according to claim 5, wherein the pin member is provided in a plurality at equally spaced intervals centered on the rotation axis of the impeller.
7. The turbomachinery according to claim 4, wherein the rotation inhibiting member comprises:

a fitting projection whose outer shape seen from the rotation axis direction of the impeller deviates from the rotation body shape, and is provided projecting in the rotation axis direction with respect to the impeller or the shaft, and a fitting hole that is provided in the impeller or

the shaft where the fitting projection is not provided, and in which the fitting projection is fitted.

8. The turbomachinery according to claim 7, wherein the fitting projection has a shape whose center of gravity is on the rotation axis. 5
9. The turbomachinery according to claim 1, comprising a lock bolt that abuts the two-way screw from the rotation axis direction of the impeller. 10
10. The turbomachinery according to any one of claims 1 to 9, wherein the turning direction of the screw thread that is formed on the impeller screwing region is set to a direction in which the fastening power between the two-way screw and the impeller increases due to a reactive force when the impeller is rotatively driven. 15
11. The turbomachinery according to any one of claims 1 to 9, wherein a fitting hole or a fitting projection that is capable of fitting a tool that rotates the two-way screw is provided on the impeller-side end face of the two-way screw, and an exposure hole that exposes the fitting hole or the fitting projection is provided in the impeller. 20 25
12. The turbomachinery according to claim 10, wherein a fitting hole or a fitting projection that is capable of fitting a tool that rotates the two-way screw is provided on the impeller-side end face of the two-way screw, and an exposure hole that exposes the fitting hole or the fitting projection is provided in the impeller. 30 35
13. The turbomachinery according to claim 11, wherein the fitting hole or the fitting projection that is capable of fitting a tool that rotates the two-way screw has a shape whose center of gravity is on the rotation axis of the impeller. 40
14. The turbomachinery according to claim 12, wherein the fitting hole or the fitting projection that is capable of fitting a tool that rotates the two-way screw has a shape whose center of gravity is on the rotation axis of the impeller. 45

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FIG. 1

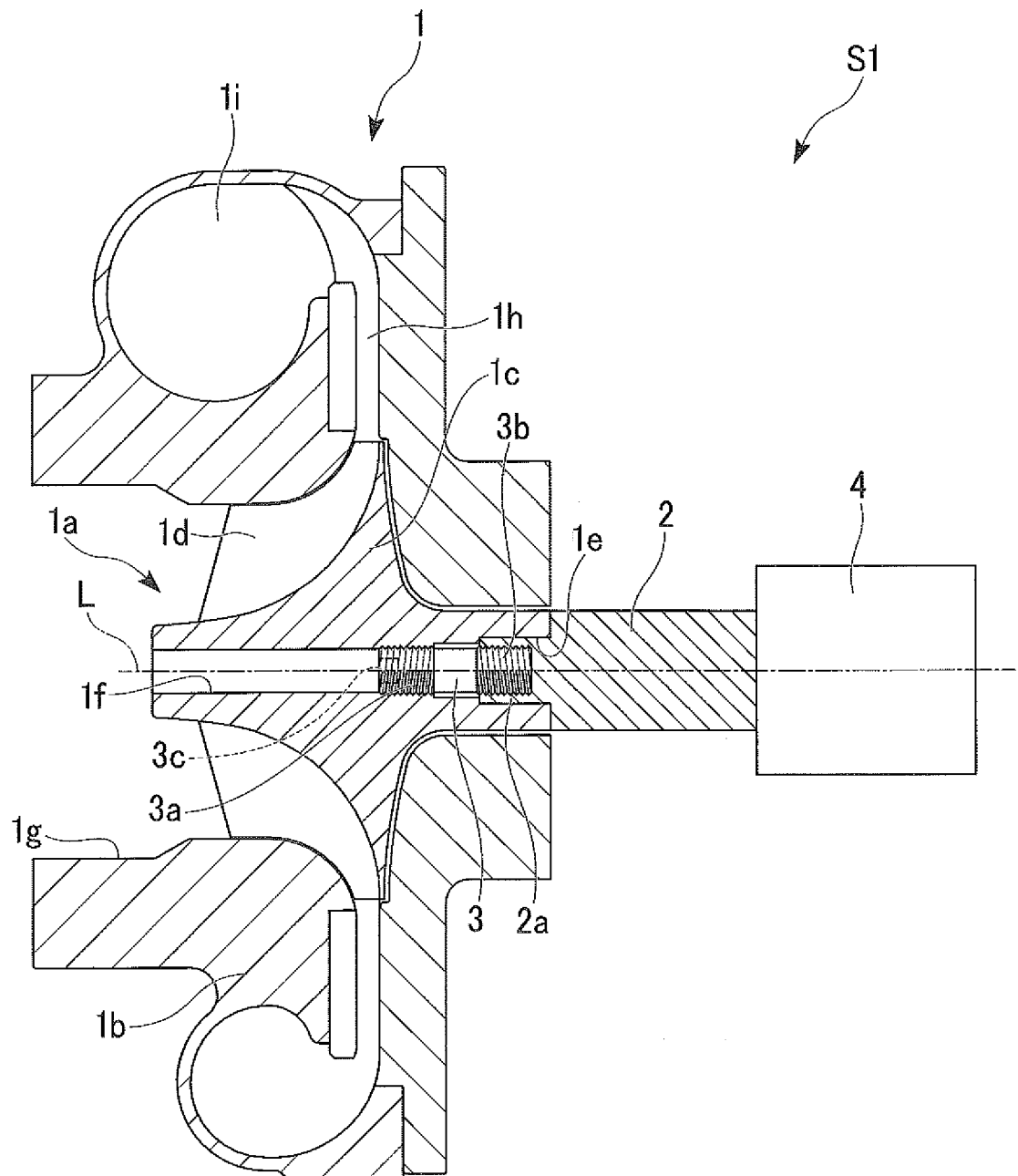


FIG. 2

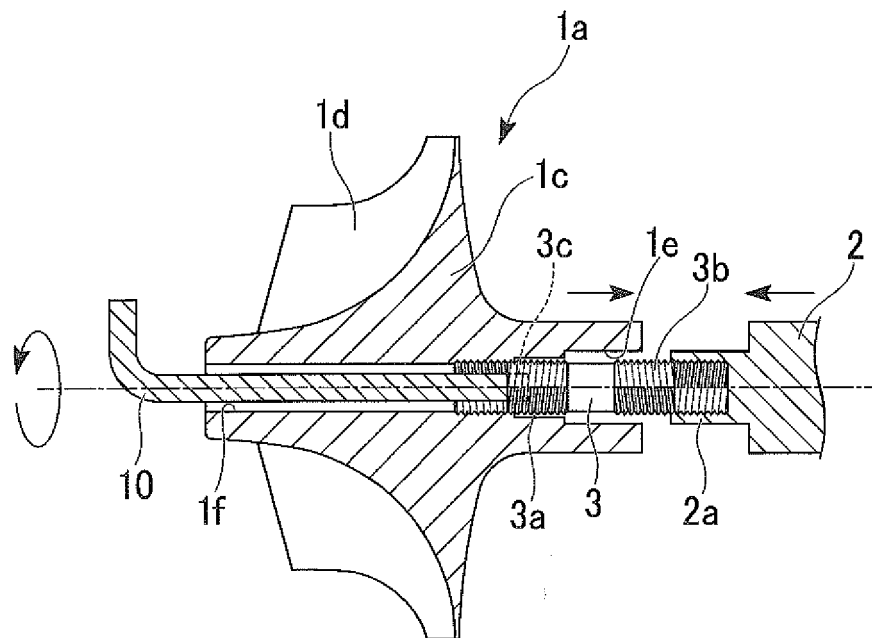


FIG. 3A

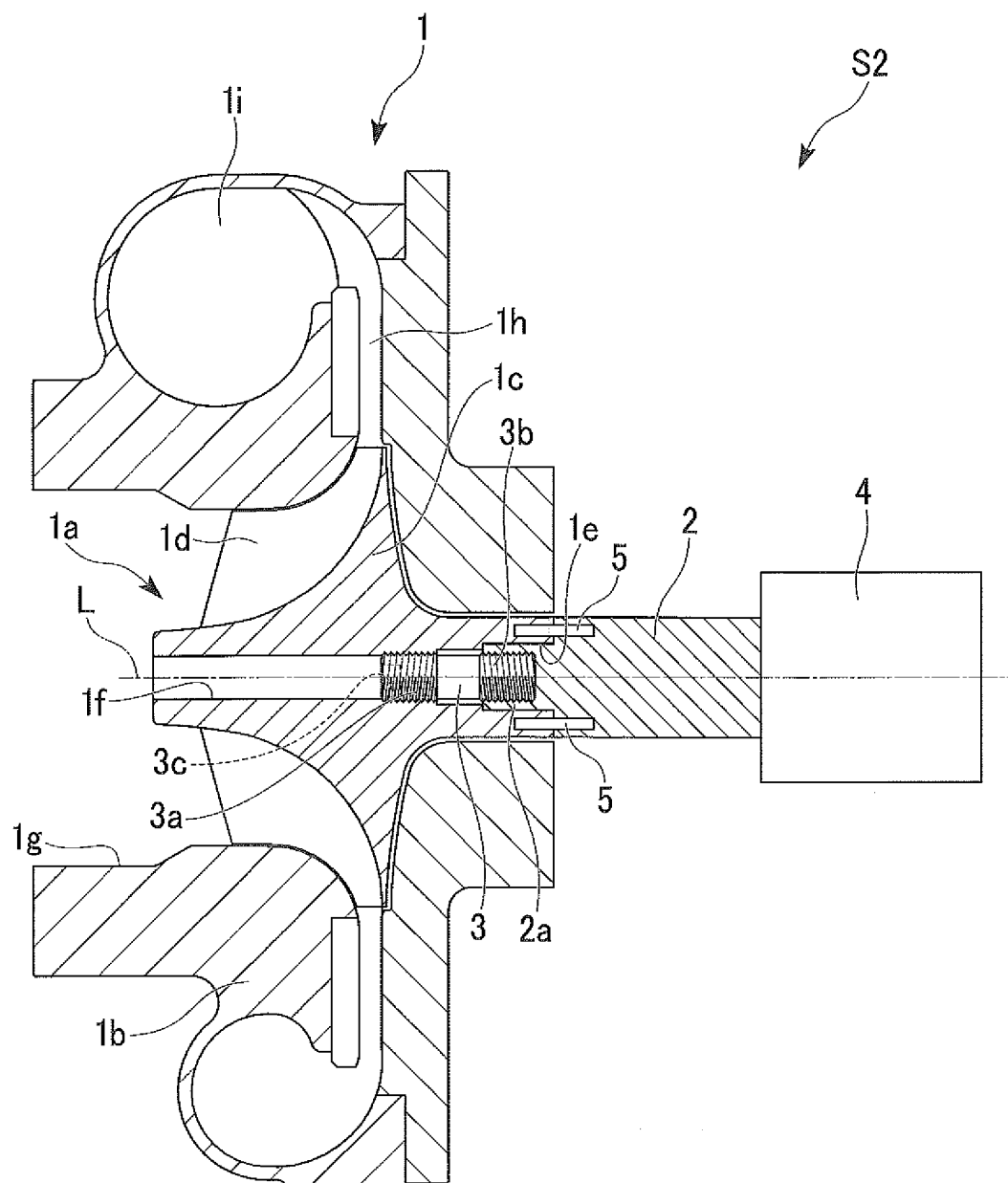


FIG. 3B

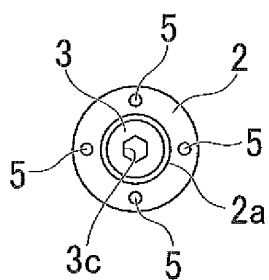


FIG. 4A

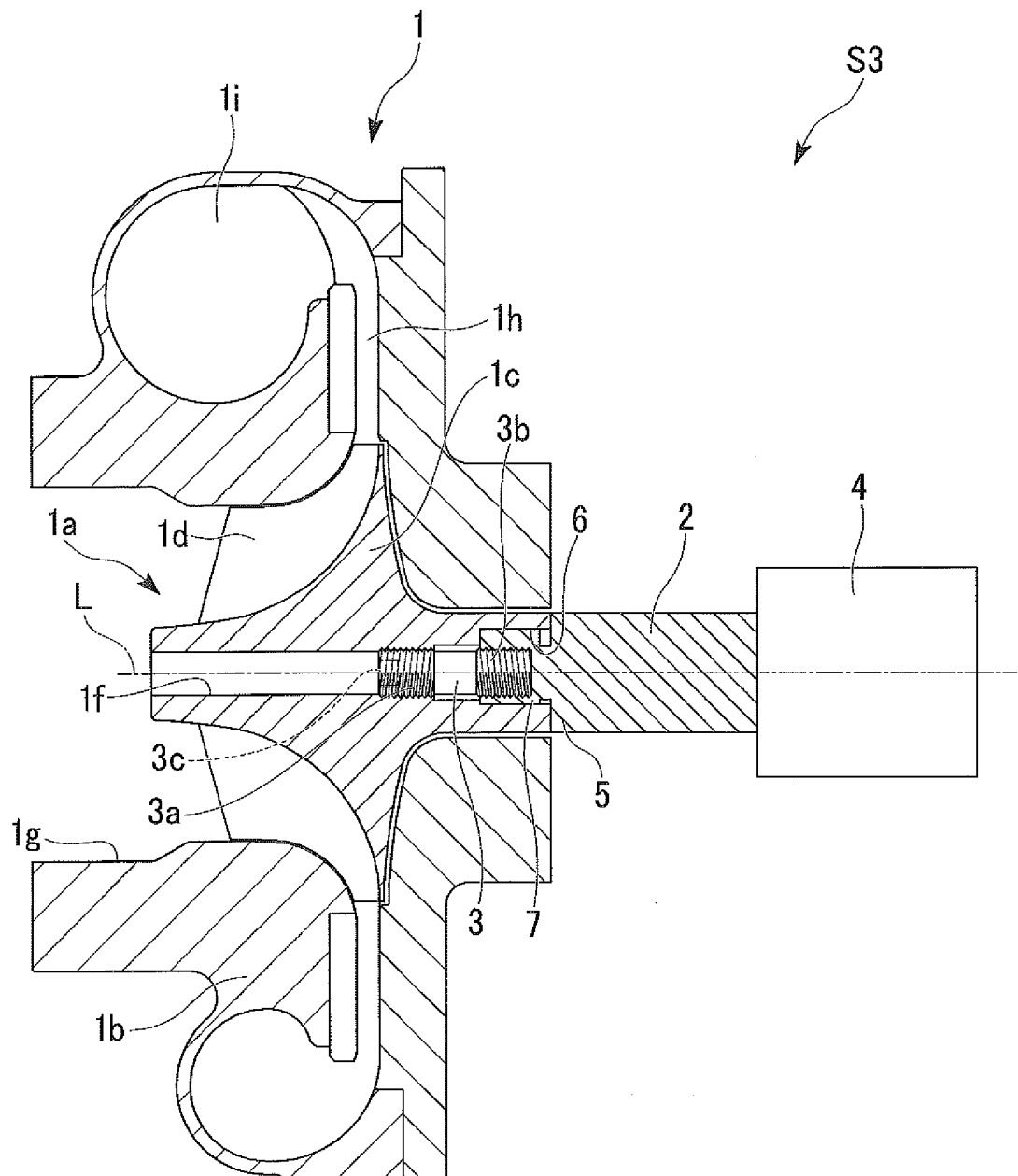


FIG. 4B

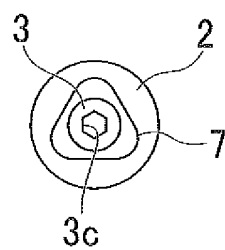


FIG. 5

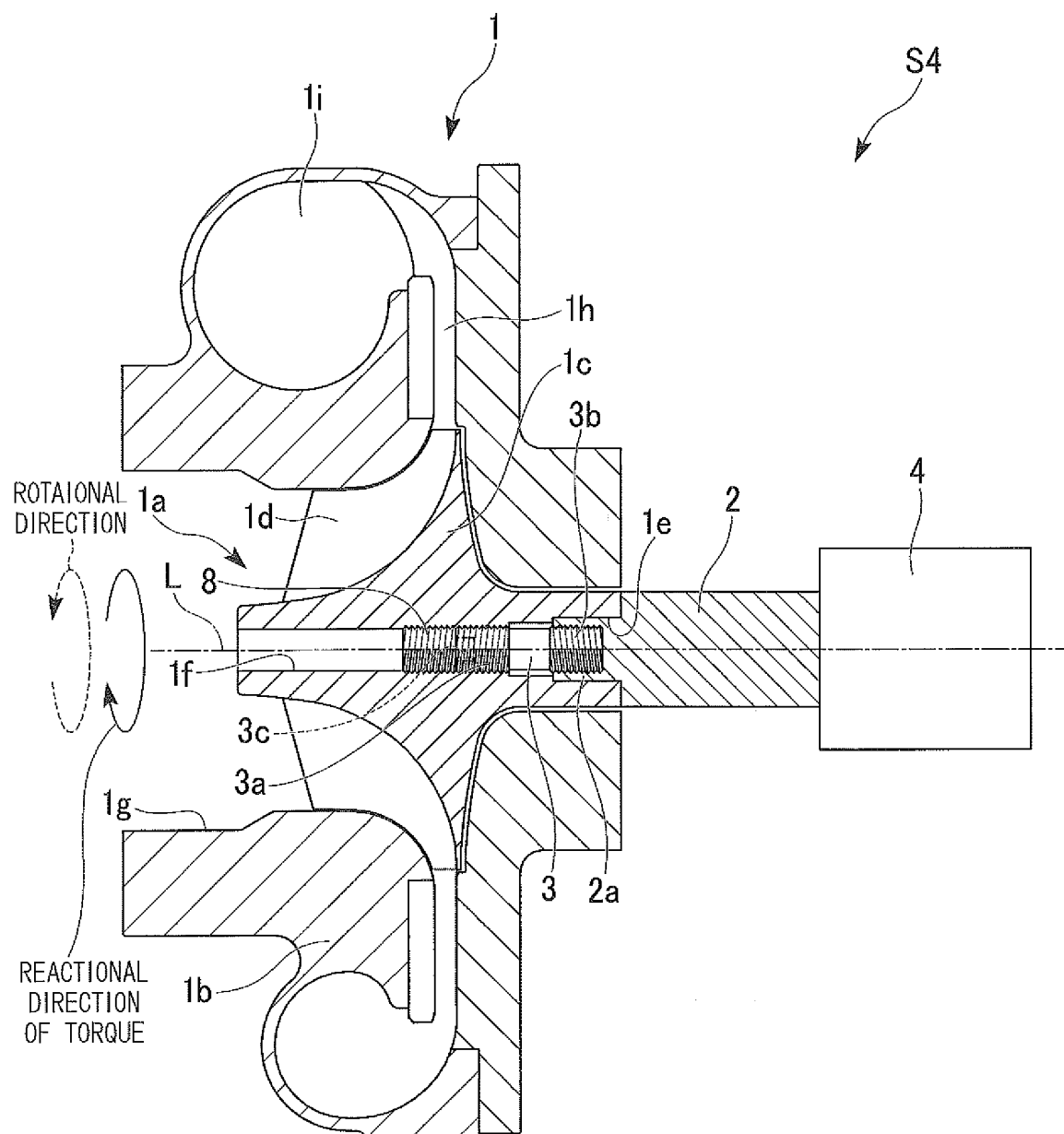
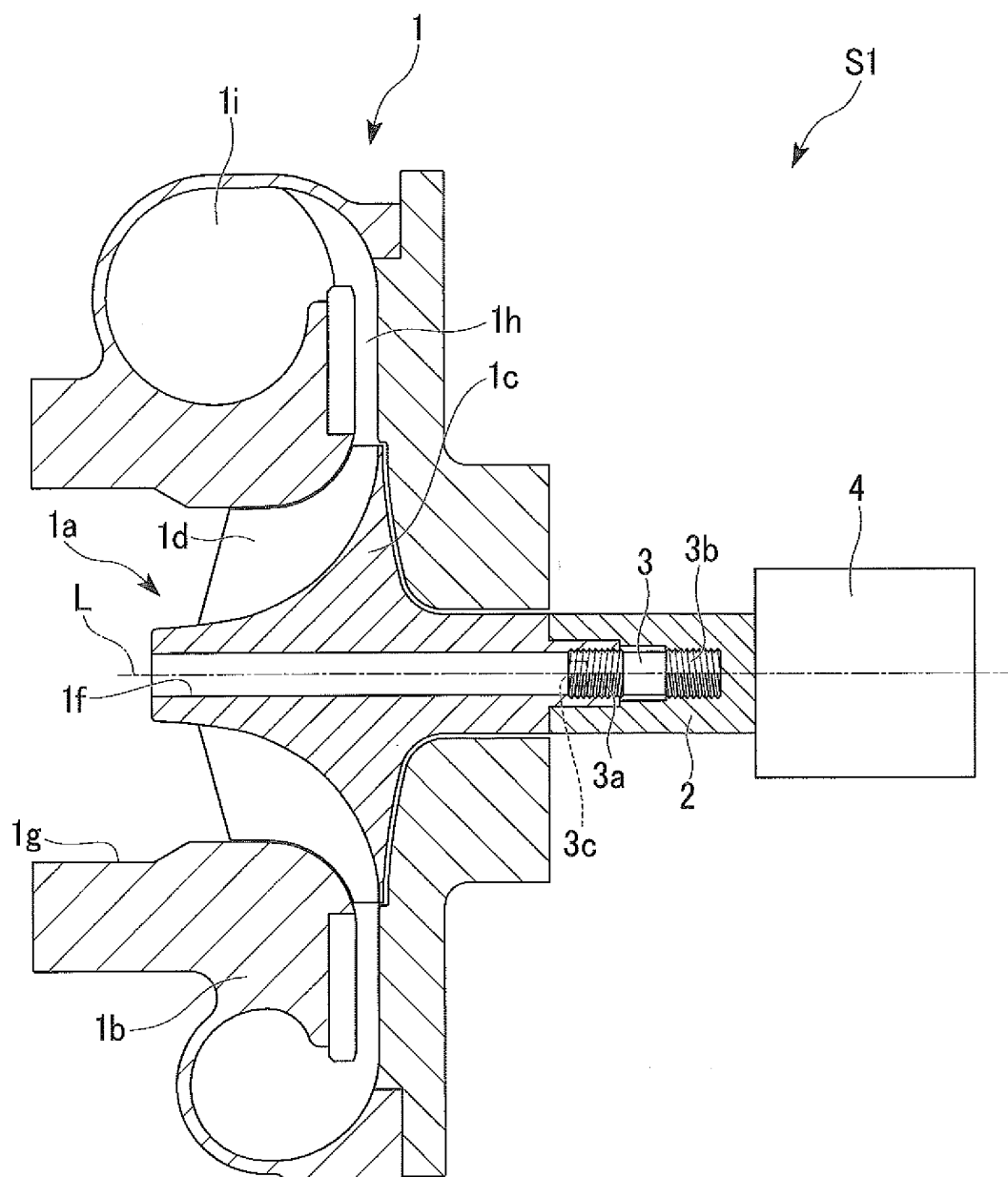


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/054077

A. CLASSIFICATION OF SUBJECT MATTER

F04D29/28 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04D29/28

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2008-133745 A (IHI Corp.), 12 June 2008 (12.06.2008), entire text; all drawings & CN 101235826 A	1-14
A	JP 2004-218572 A (Tsurumi Manufacturing Co., Ltd.), 05 August 2004 (05.08.2004), entire text; all drawings (Family: none)	1-14
A	JP 11-148492 A (Asea Brown Boveri AG.), 02 June 1999 (02.06.1999), entire text; all drawings & US 6012901 A & EP 903465 A1	1-14

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search
11 May, 2012 (11.05.12)Date of mailing of the international search report
22 May, 2012 (22.05.12)Name and mailing address of the ISA/
Japanese Patent Office

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Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2012/054077

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 182732 C2 (Gebrüder Sulzer AG.), 29 September 1956 (29.09.1956), entire text; all drawings (Family: none)	1-14
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 125572/1984 (Laid-open No. 39498/1986) (Kubota Tekko Kabushiki Kaisha), 12 March 1986 (12.03.1986), entire text; all drawings (Family: none)	1-14
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 88016/1980 (Laid-open No. 11298/1982) (Hitachi, Ltd.), 20 January 1982 (20.01.1982), entire text; all drawings (Family: none)	1-14
A	JP 2003-181755 A (Hitachi Plant Engineering & Construction Co., Ltd.), 02 July 2003 (02.07.2003), fig. 4 (Family: none)	1-14
A	JP 8-308434 A (Kanzaki Kokyukoki Mfg. Co., Ltd.), 26 November 1996 (26.11.1996), fig. 6 (Family: none)	1-14

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2011034519 A [0001]
- JP H0552356 B [0003]
- JP H0557450 B [0003]